Examiner states that Mikus and Minet et al. are analagous art in that both deal with combusting a fluid fuel in order to heat another part of an apparatus and that it would have been obvious at the time of the invention to combine the apparatus of Minet with the multiple nozzles of Mikus with the motivation being to extend the region being heated by the heating unit and further motivation being to accomplish a nearly even temperature distribution within the apparatus (Mikus, col. 5, lines 46-47).

Examiner acknowledges that Minet fails expressly to disclose an oxidant preheater and fuel nozzles capable of distributing fuel into the oxidation chamber without forming a flame. However, Examiner states that Mikus discloses a preheater in communication with the oxidation chamber inlet, the preheater capable of increasing the temperature of the oxidant (Mikus, col. 9, lines 39-55) and that Mikus also discloses a plurality of fuel nozzles (Mikus, Fig. 1(13)), capable of distributing fuel into the oxidation chamber without forming a flame (Mikus Abstract).

Examiner asserted that at the time of the invention it would have been obvious to one skilled in the art to combine the modified apparatus of Minet et al. with the preheater of Mikus, with the motivation being to preheat the gas in order to bring about flameless combustion. Examiner states Minet, in Fig. 1 discloses a process chamber in a heat exchange relationship with the oxidation reaction chamber, and further that it would have been obvious to modify the apparatus of Minet with the flameless combustion features of Mikus to get the invention of Claim 1, thereby achieving more even heating in Minet's reactor apparatus (Mikus Abstract: "...results in a more even temperature distribution throughout the length of the burner").

Applicant respectfully asserts that if one objectively views the factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459, for determining obviousness one of ordinary skill in the art at the time of filing the present invention could not have found the present invention obvious observing Minet et al., in view of Mikus.

The criteria were:

1. Determining the scope and contents of the prior art.

   Minet et al. suggests a process heater that utilizes indirect heating to eliminate hot spots caused by radiated heat. The indirect fired heaters suggested by Minet el al. address the

problem of the hot spots on furnace tubes, but a separate heater is required for reheat, and isothermal, or nearly isothermal, processes are not possible. Mikus teaches a method for heat injection into a subterranean formation. Applicant respectfully asserts it would not be obvious for one of ordinary skill in the art to use the teachings of Mikus as suggested by examiner without relying on hindsight.

2. Ascertaining the differences between the prior art and the claims at issue.

The present invention is a flameless combustor as a process heater which exhibits numerous unexpected results and improvements set forth below and incorporated by reference in the entirety from the Amendment, dated September 29, 2000, page 3, entire page, responding to the First Office Action:

a) As described at page 4, starting at the last paragraph, the heater used in endothermic reactions can achieve improved conversions, selectivities and/or yields and reduced byproducts due to the uniform heat inputs and reduced hot spots achievable by the use of the flameless distributed combustion.

b) As described at page 5, lines 10-15, interstage reheats can be eliminated, thus enabling operation at an optimum temperature.

c) As described at page 7, lines 22-24, the advantage of even temperature profiles with respect to material of construction is discussed.

d) As described at page 13, lines 11-21, advantages with respect to production of styrene include the fact that the reactor can operate essentially isothermally, thus benefiting from operating at an optimum temperature.

e) As described at page 14, lines 10-13, advantages with respect to steam methane reforming include the fact that since hydrogen purity is dictated by the temperature of the reaction and typical steam methane furnaces have burners which limit the purity and /or limit the minimum steam required, with the present invention the average process temperature can be considerably higher because the reactor tubes are of uniform temperature, thus either less volume of catalyst, higher purity, less steam, or a combination of these advantages can be realized.

f) As described at page 14, line 27 through line 2 of page 15, advantages for application to thermal cracking of hydrocarbons include the fact that while typically coke forms quickly at hot spots and therefore tube skin temperatures need to be kept low enough so that the hottest tube skins locations do not form coke on the process side, in the present invention, with the uniform heat fluxes possible, higher heat fluxes are possible.

3. Resolving the level of ordinary skill in the pertinent art.

Applicant respectfully asserts that examiner has not substantiated how one of ordinary skill in the art would have found the present invention obvious. The accepted standard is not an advanced degree in the art. Applicant includes herewith an affidavit written by a doctor of chemical engineering who presents objective data and asserts the present invention would not have been obvious from Minet el al. in view of Mikus. Therefore, it is respectfully asserted it would not have been possible for one of ordinary skill in the art to find the invention obvious.

4. Considering objective evidence present in the application indicating obviousness.

Applicant respectfully asserts that evidence of unobviousness has been itemized above and has enclosed herewith an Affidavit under 37 C.F.R. §1.132, by Dr. Andreas Matzakos, who has a Ph.D. in chemical engineering, containing proof of the unexpected results claimed herein in the form of data from a rigorous reactor model written in FORTRAN with thousands of lines of code which has been used successfully to predict other reactors. The model, named STYRENE, accounts for homogeneous and heterogeneous kinetics, diffusional limitations, catalyst deactivation, and pressure drop. The model performs heat and mass balances in each reactor stage and the preheat zones. The model can also regress pilot or plant data to determine the best kinetic parameters. Dr. Matzakos found the reactor as described in Claim 1 can potentially run near isothermally, along with numerous other unexpected improvements. In the case of use for making styrene, it can achieve at least twice or greater the capacity of conventional styrene reactor.

Dr. Matzakos is also closely involved in the business aspects of this art and provides objective evidence in the form of personal knowledge of commercial success that the present invention fills a need in the art.

Examiner also rejected Claim 2, stating Mikus discloses a coke inhibitor injector system, the coke inhibitor system in communication with the fuel supply and that it would have been obvious to combine the modified apparatus of Minet with the inhibitor system of Mikus.

Applicant asserts the unobviousness of Claim 1 has been demonstrated and, therefore, dependent Claim 2.

Examiner stated with regard to Claim 3 that Minet dislcoses a fuel conduit that is essentially a tubular conduit centrally located with the oxidation reaction chamber (Minet, Fig. 1, 41 & 46). Applicant asserts that Claim 3, dependent on Claim 1, should now be allowable.

Examiner stated with regard to Claim 4, Minet discloses an oxidation chamber that is essentially located within the process chamber (Minet, Fig. 1). Claim 4, dependent on Claim 1, should now be allowable.

Claims 5, 6, and 7, dependent on Claim 1, should now be allowable.

Applicant respectfully asserts it has addressed each of Examiner's reasons for rejection and allowance of Claims 1-7 is respectfully requested.

Each of the rejections having been traversed, allowance of the remaining claims is respectfully requested. If the Examiner would like to discuss this application, it is respectfully requested that the undersigned by contacted at (713) 241-3997.

Respectfully submitted,

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Enclosure: Affidavit
Petition for continuing prosecution application